10/505152
DT15 Rec'd PCT/PTO 20 AUG 2004

DRILL MEMBER FOR ROCK DRILLING AND A METHOD FOR MANUFACTURING THE DRILL MEMBER

Background of the invention

The present invention relates to a drill member for rock drilling and a method for manufacturing a drill member in accordance with the preambles of the appended independent claims.

Related art

At percussive top hammer drilling in rock a drill string is intended to be fastened to a shank adapter in a drilling machine via one end surface of a rod or a tube. The other end of the rod or the tube is threaded either to another rod or another tube or a drill bit for percussive drilling. The rod or the tube can also be fastened to the shank adapter or another part with the aid of threaded sleeves. A flush channel runs through the entire drill string in order to lead flush medium to the drill bit for flushing away drill cuttings.

At the drilling the drill string members, i.e. bits, rods, tubes, sleeves and shank adapters, are subjected to corrosive attacks. This applies especially at drilling below earth where water is used as flush medium and where the environment is moist. Corrosive attacks are especially serious at the most stressed parts, i.e. at thread bottoms and other reductions. In combination with pulsating strain, caused by impact waves and bending stresses, so-called corrosion fatigue arises. This is a usual cause for breakage of the drill string.

Generally a low alloyed case hardened steel is used in the drill member. The reason for this is that abrasion and wear of the thread portions have for long been limiting the life spans. As the drilling machines and the drill members become better these problems have diminished and corrosion fatigue become a limiting factor.

The case hardening gives compressive stresses in the surface, which give certain effect against the mechanical part of the fatigue. Corrosion resistance of low alloyed steel is however poor and for that reason corrosion fatigue still occurs easily. The resistance is however not satisfactorily and so breakages often occur.

In US-A-4,872,515 or US-A-5,064,004 a drill member is shown where a threaded portion has been provided with a metallic material, which is softer than the steel of the drill member. Thereby is intended to solve the problem of frictional damages (pitting) in the threads by covering at least the parts of the thread of the drill member that cooperate with other parts of the threaded connection.

One method of eliminating corrosion fatigue is to make the rods in stainless steel such as in SE-A-0000521-5. The stainless steel is however relatively soft and consequently has inferior wear resistance than a carburized rod, i.e. it wears out relatively quickly.

Through SE-C2-515 195 and SE-C2-515 294 thread joints for percussive rock drilling are shown. By covering the thread bottoms of the cylindrical external thread with at least one layer of a material with other electrode potential than the underlying steel an increased tool life for the threaded connection is attained.

Objects of the invention

One object of the present invention is to considerably improve the resistance to corrosion fatigue in a drill member for percussive rock drilling.

Another object of the present invention is to considerably improve the resistance to corrosion fatigue at sections with reduced thickness of the material in a drill member for percussive rock drilling.

Still another object of the present invention is to considerably improve the resistance to corrosion fatigue in thread bottoms in a threaded portion in a drill member for percussive rock drilling.

Still another object of the present invention is to provide a method for manufacturing a drill member with improved resistance against corrosion fatigue for percussive rock drilling.

Brief description of the drawings

These and other objects have been achieved by a thread joint and a drill member with features according to the characterizing portions in the appended independent claims with reference to the drawings.

Fig. 1A shows a tube and Fig. 1B shows a rod, both in perspective views.

Fig. 2 shows a blank for extrusion in a perspective view.

Fig. 3 shows an extruded rod in a perspective view.

Fig. 4 shows an axial cross-section of a part machined from the rod in Fig. 3.

Fig. 5A shows an axial cross-section of a male portion according to the present invention after machining of the part according to Fig. 4.

Fig. 5B shows a photo of the portion in Fig. 5A.

Fig. 5C shows an enlarged sectional view of the thread in Fig. 5A.

Fig. 5D shows a photo of an about 10 times enlarged sectional view of the thread in Fig. 5B.

Fig. 6 shows a drill rod according to the present invention in a side view.

Fig. 7 shows an axial cross-section of a female portion according to the present invention.

Detailed description of the invention

The invention relates to a drill member for rock drilling and a method for manufacturing a drill member with a flush channel for percussive drilling with at least one reduction or a portion 40, 40' with relatively thin thickness of the material, which is performed in homogenous stainless steel in order to considerably improve the resistance against corrosion fatigue. In addition, the flush channel is in one case performed in the same stainless steel and therefore corrosion fatigue therein no longer occurs during rock drilling.

According to the invention a drill member is provided for percussive drilling, that is, a male portion 19 (Fig. 5A) or a female portion 26 (Fig. 7) equipped with an external thread 16 and an internal thread 16', respectively. The threads shown are so called cylindrical trapezoidal threads but other thread shapes may be used, for example conical threads or rope threads or a combination of these.

With reference mainly to Figs. 5A and 5C the drill member 19 has a through flush channel 20, through which a flush medium, generally air or water, is led. The thread 16 comprises thread bottoms 23 and thread crests 24, with thread flanks 21, 22 provided therebetween. The thread bottoms 23 are performed in stainless steel and the thread crests 24 in low alloyed steel.

The thread 16 has a depth D, which is defined as the perpendicular distance between the thread bottom 23 and the thread crest 24 and the low alloyed portion of the thread crest 18 has a thickness T after machining. The depth D is generally in the range of 1-4 mm and the outer diameter of the rod is 20-70 mm. The ratio T/d is 0.1-1.0, preferably 0.4-0.8. In a preferred embodiment a trapezoidal thread (T38) with a depth D = 2-2.5 mm and a shell 18 with a thickness T of 1-2 mm, preferably around 1.5 mm is used.

The thread bottom 23 and the stainless portion of the thread flanks 21, 22 have a first width W1, and the thread crest 24 and the low alloyed portion of the thread flanks 21, 22 have a second width W2 (Fig. 5C), where the ratio W1/W2 is 0-0.9, preferably 0.3 - 0.8. The widths W1 and W2 of the thread bottom 23 and the thread crest 24, respectively, can be defined as the largest length of the respective material in the longitudinal direction of the member exposed towards the surroundings. A male portion according to the present invention according to Fig. 5B with a trapezoidal thread (T38) with W1 = 6.1 mm and W2= 9.5 mm and ratio W1/W2=0.64.

By making the thread bottoms 23 in one embodiment in stainless steel the male portion 19 has great resistance against corrosion fatigue. The stainless steel has a composition which gives a PRE value >10, preferably 12-17. PRE means Pitting Resistance Equivalent and describes the resistance of the alloy against pitting. PRE is defined according to formula

$$PRE = Cr + 3.3(Mo + W) + 16N$$

where Cr, Mo, W and N corresponds to the contents of the members in weight percent.

That low alloyed steel in the shell 18 has a hardness >500 Vickers, most preferably 650-800 Vickers whereby good wear resistance will be obtained. The hardness can be obtained by making the component in tough hardened steel, by

carburizing the surface or by induction surface hardening. The low alloyed steel preferably has a composition in weight%

C	0.1-0.7
Si	0.1-1
Mn	0.2-2
Cr	<5
Ni	<5
Mo	<2

the rest being Fe and inevitable impurities.

Male portions or drill members according to the invention are made as follows. In Fig. 1A a tube is shown 11 and in Fig. 1B a rod 12 is shown. The tube 11 and the rod 12 are fitted with fine tolerances, for example by shrink fit, into each other to form a blank 13 such as is apparent from Fig. 2 and are fixed by circumferential welds 14 at the ends of the blank. In addition the welds 14 give a protection against oxidation at the interface between the tube 11 and the rod 12 at the subsequent heating. The blank 13 is extruded in hot condition to a compound component 15 with diameter that is adapted to the desired dimension of a thread 16 for percussive rock drilling (see Fig. 5A). With "compound component" is here meant an extruded tube or an extruded rod of at least two different materials.

The compound component in the shown embodiment is made of a rod 15 with a core 17 of stainless steel and a shell 18 of low alloyed steel. From this rod a conventional external thread or male thread for percussive rock drilling 16 is turned, such that thread bottoms are obtained in the stainless core 17. Alternatively, the core 17' consists of low alloyed steel and the shell 18' of stainless steel (Fig. 7). From this rod a conventional inner thread or female thread 16' for percussive rock drilling is turned, such that thread bottoms are obtained in the stainless portion 18'. The thread 16, 16' consequently shall consist of at least two different materials. The machined ends are carburized in order to give hardness and wear resistance to the flanks of the thread 16, 16'. Coating these portions in order to avoid carburization thereof protects the stainless steel. The machined ends are then friction welded to a hexagonal rod or to a round rod of low alloyed or stainless steel (see Fig. 6) to a drill rod 25 which finally is hardened and annealed.

A central flush channel is drilled. Alternatively, a tube can replace the rod 12 such that the finished extruded compound component 15 is made of a tube such that one doesn't have to drill a hole. In the latter case the extrusion blank 13 shall have a hole for a mandrel and therefore the rod that will constitute the core instead may be a tube blank or a solid rod that is drilled.

Both the male portion 19 and the female portion 26 comprise impact transferring surfaces, that is, the end surface 19A and the bottom surface 26A, respectively.

EXAMPLE

Extrusion blanks 13 were manufactured from tubes 11 of low alloyed steel, with composition 1, outer diameter 77 mm and inner diameter 63 mm and stainless rod 12, with composition 2 and diameter 63 mm. The blanks were heated to 1150°C and were extruded to rods with outer diameter of 43 mm. The diameter for the stainless steel was 35 mm. Investigations in light microscope showed that the metallurgical bond between the low alloyed and the stainless steel was good, see Fig. 5D. From the rods obtained through this procedure male portions 19 were manufactured by means of conventional machining. The thread was of the type T38 with outer diameter 38 mm and had the depth 2.35 mm. These were then case hardened, during which the exposed surfaces of stainless steel were covered by protective coating for avoiding effects of the carbon containing gaseous atmosphere. The male portions were then friction welded to respective ends of a rolled rod 25, which included a flush channel. The male portions have a composition according to 3 below. Subsequently a flush channel was drilled in each male portion and all rods were hardened from 1030°C.

	%C	%Si	%Mn	%Cr	%Ni	%Mo	%Fe
1	0.22	0.21	0.57	1.26	2.62	0.22	rest
2	0.21	0.61	0.46	12.9	0.11	0.02	rest
3	0.19	0.27	0.45	13.3	0.29	0.02	rest

Five finished rods were put into in a rig for so called drifter drilling below earth and were drilled until fracture/wearing-out occurred. The following life spans, measured in so-called drilled meter, were obtained:

Rod 1	7200 m
Rod 2	6223 m
Rod 3	6888 m
Rod 4	8901 m
Rod 5	6054 m

Normal tool life for standard drill tubes, that is case hardened low alloyed steel of the same type as the shell 18, is about 5000 m, which shows that the drill member according to the present invention exhibits a sharp increase in tool life.

The invention relates primarily to drifter rods, i.e. rods with male portions at both ends. One can however imagine also to make drill tubes or MF rods by the method according to the present invention. The latter has both male and female portion (MF=Male-Female).

In an alternative embodiment the entire thread may be performed in low alloyed steel wherein the stainless steel does not reach the bottom of the thread in the radial direction. In this way the stainless steel retards corrosion fatigue when the low alloyed steel is broken through by corrosion induced cracks.